CLAIMS

[1] A hydrogen generating apparatus comprising:

a hydrogen generator including a reformer configured to generate a reformed gas from a material and steam; a shift converter configured to cause the reformed gas supplied from said reformer to be subjected to a shift reaction; and a selective oxidation device configured to decrease a concentration of carbon monoxide in the reformed gas after the shift reaction;

a temperature sensor configured to detect one of a temperature of said shift converter and a temperature of said selective oxidation device; and

a controller configured to determine that excess water or excess steam exists in an interior of said hydrogen generator when an increasing rate of the temperature detected by said temperature sensor is less than a predetermined threshold.

[2] The hydrogen generating apparatus according to claim 1, wherein said controller is configured to determine that the excess water or the excess steam exists in an interior of said shift converter when an increasing rate of the temperature of said shift converter that is detected by said temperature sensor is less than a predetermined threshold.

[3] The hydrogen generating apparatus according to claim 1, wherein said controller is configured to determine that the excess water or the excess steam exists in an interior of said selective oxidation device when an increasing rate of the temperature of said selective oxidation device that is detected by said temperature sensor is less than a predetermined threshold.

[4] A hydrogen generating apparatus comprising:

a hydrogen generator including a reformer configured to generate a reformed gas from a material and steam; a shift converter configured to cause the reformed gas supplied from said reformer to be subjected to a shift reaction; and a selective oxidation device configured to decrease a concentration of carbon monoxide in the reformed gas after the shift reaction to a predetermined concentration or less;

a temperature sensor configured to detect one of a temperature of said shift converter and a temperature of said selective oxidation device; and

a controller configured to perform control to decrease water or steam in an interior of said hydrogen generator when an increasing rate of the temperature detected by said temperature sensor is less than a predetermined threshold.

[5] The hydrogen generating apparatus according to claim 4, further comprising:

a water supply device configured to supply the water or the steam to said hydrogen generator,

wherein said controller is configured to control said water supply device to decrease an amount of the water or the steam supplied to the interior of said hydrogen generator when the increasing rate of the temperature detected by said temperature sensor is less than the predetermined threshold.

[6] The hydrogen generating apparatus according to claim 4, further

comprising:

a water discharge device that is equipped in said shift converter and is configured to discharge the water;

wherein said controller is configured to control said water discharge device to discharge the water from an interior of said shift converter to outside when an increasing rate of the temperature of said shift converter that is detected by said temperature sensor is less than a predetermined threshold.

[7] The hydrogen generating apparatus according to claim 4, further comprising:

a water discharge device that is equipped in said selective oxidation device and is configured to discharge the water;

wherein said controller is configured to control said water discharge device to discharge the water from an interior of said selective oxidation device to outside when an increasing rate of the temperature of said selective oxidation device that is detected by said temperature sensor is less than a predetermined threshold.

[8] The hydrogen generating apparatus according to claim 4, further comprising:

an air supply device configured to supply air to said shift converter;

wherein said controller is configured to control said air supply device to introduce the air to the interior of said shift converter when an increasing rate of the temperature of said shift converter that is detected by said temperature sensor is less than a predetermined threshold.

[9] The hydrogen generating apparatus according to claim 4, further comprising:

an air supply device configured to supply air to said selective oxidation device;

wherein said controller is configured to control said air supply device to introduce the air to an interior of said selective oxidation device when an increasing rate of the temperature of said selective oxidation device that is detected by said temperature sensor is less than a predetermined threshold.

[10] The hydrogen generating apparatus according to claim 4, further comprising:

a heating device configured to heat said shift converter;

wherein said controller is configured to control said heating device to heat an interior of said shift converter when an increasing rate of the temperature of said shift converter that is detected by said temperature sensor is less than a predetermined threshold.

[11] The hydrogen generating apparatus according to claim 4, further comprising:

a heating device configured to heat said selective oxidation device;

wherein said controller is configured to control said heating device to heat an interior of said selective oxidation device when an increasing rate of the temperature of said selective oxidation device that is detected by said temperature sensor is less than a predetermined threshold.

[12] A fuel cell system comprising:

a hydrogen generating apparatus according to any one of claims 1 to 11; and

a fuel cell configured to generate electric power using a reformed gas supplied from said hydrogen generating apparatus and an oxidizing gas.

[13] A method of operating a hydrogen generating apparatus comprising a hydrogen generator including a reformer configured to generate a reformed gas from a material and steam; a shift converter configured to cause the reformed gas supplied from said reformer to be subjected to a shift reaction; and a selective oxidation device configured to decrease a concentration of carbon monoxide in the reformed gas after the shift reaction; and a temperature sensor configured to detect one of a temperature of said shift converter and a temperature of said selective oxidation device, said method comprising:

decreasing water or steam in an interior of said hydrogen generator when an increasing rate of the temperature detected by said temperature sensor is less than a predetermined threshold.

[14] A method of operating a fuel cell system comprising a hydrogen generator including a reformer configured to generate a reformed gas from a material and steam; a shift converter configured to cause the reformed gas from said reformer to be subjected to a shift reaction; and a selective oxidation device configured to decrease a concentration of carbon monoxide in the

reformed gas after the shift reaction to a predetermined concentration or less; a fuel cell configured to generate electric power using the reformed gas supplied from said reformer and an oxidizing gas; and a temperature sensor configured to detect one of a temperature of said shift converter and a temperature of said selective oxidation device, said method comprising:

decreasing water or steam in an interior of said hydrogen generator when an increasing rate of the temperature detected by said temperature sensor is less than a predetermined threshold.

[15] A hydrogen generating apparatus comprising:

a hydrogen generator including a reformer configured to generate a reformed gas from a material and steam; a shift converter configured to cause the reformed gas supplied from said reformer to be subjected to a shift reaction; a selective oxidation device configured to decrease a concentration of carbon monoxide in the reformed gas after the shift reaction to a predetermined concentration or less; a reformer heater configured to heat said reformer;

a combustion sensor configured to detect a combustion state of a combustible gas in said reformer heater; and

a controller configured to determine that excess water or steam exists in an interior of said hydrogen generator when a detection signal detected by said combustion sensor reaches, with a frequency of predetermined number of times or more, a numeric value at which a flame vanishes in said reformer heater, during a time period that elapses from when a temperature of said shift converter reaches a shift reaction temperature range until a

temperature of said selective oxidation device reaches a selective oxidation reaction temperature range.

[16] A hydrogen generating apparatus comprising:

a hydrogen generator including a reformer configured to generate a reformed gas from a material and steam; a shift converter configured to cause the reformed gas supplied from said reformer to be subjected to a shift reaction; a selective oxidation device configured to decrease a concentration of carbon monoxide in the reformed gas after the shift reaction to a predetermined concentration or less; a reformer heater configured to heat said reformer;

a combustion sensor configured to detect a combustion state in said reformer heater; and

a controller configured to perform control to decrease water or steam in an interior of said hydrogen generator when a detection signal detected by said combustion sensor reaches, with a frequency of predetermined number of times or more, a numeric value at which a flame vanishes in said reformer heater, during a time period that elapses from when a temperature of said shift converter reaches a shift reaction temperature range until a temperature of said selective oxidation device reaches a selective oxidation reaction temperature range.

[17] The hydrogen generating apparatus according to claim 16, further comprising:

a water supply device configured to supply the water or the steam to

said hydrogen generator,

wherein said controller is configured to control said water supply device to decrease an amount of the water or the steam supplied to the interior of said hydrogen generator when a detection signal detected by said combustion sensor reaches, with a frequency of predetermined number of times or more, a numeric value at which a flame vanishes in said reformer heater, during a time period that elapses from when a temperature of said shift converter reaches a shift reaction temperature range until a temperature of said selective oxidation device reaches a selective oxidation reaction temperature range.

[18] The hydrogen generating apparatus according to claim 16, further comprising:

a water discharge device that is equipped in said shift converter and/or said selective oxidation device and is configured to discharge water;

wherein said controller is configured to control said water discharge device to discharge water from an interior of said shift converter and/or an interior of said selective oxidation device to outside when a detection signal detected by said combustion sensor reaches, with a frequency of predetermined number of times or more, a numeric value at which a flame vanishes in said reformer heater, during a time period that elapses from when a temperature of said shift converter reaches a shift reaction temperature range until a temperature of said selective oxidation device reaches a selective oxidation reaction temperature range.

[19] The hydrogen generating apparatus according to claim 16, further comprising:

an air supply device configured to supply air to said shift converter and/or said selective oxidation device;

wherein said controller is configured to control said air supply device to introduce air to an interior of said shift converter and/or an interior of said selective oxidation device when a detection signal detected by said combustion sensor reaches, with a frequency of predetermined number of times or more, a numeric value at which a flame vanishes in said reformer heater, during a time period that elapses from when a temperature of said shift converter reaches a shift reaction temperature range until a temperature of said selective oxidation device reaches a selective oxidation reaction temperature range.

[20] The hydrogen generating apparatus according to claim 16, further comprising:

a heating device configured to heat said shift converter and/or said selective oxidation device;

said controller is configured to control said heating device to heat an interior of said shift converter and/or said selective oxidation device when a detection signal detected by said combustion sensor reaches, with a frequency of predetermined number of times or more, a numeric value at which a flame vanishes in said reformer heater, during a time period that elapses from when a temperature of said shift converter reaches a shift reaction temperature range until a temperature of said selective oxidation device reaches a selective

oxidation reaction temperature range.

[21] A fuel cell system comprising:

a hydrogen generating apparatus according to any one of claims 15 to 20; and

a fuel cell configured to generate electric power using a reformed gas supplied from said hydrogen generator and an oxidizing gas.

[22] A method of operating a hydrogen generating apparatus comprising a hydrogen generator including a reformer configured to generate a reformed gas from a material and steam; a shift converter configured to cause the reformed gas supplied from said reformer to be subjected to a shift reaction; a selective oxidation device configured to decrease a concentration of carbon monoxide in the reformed gas after the shift reaction to a predetermined concentration or less; a reformer heater configured to heat said reformer; and a combustion sensor configured to detect a combustion state of a combustible gas in said reformer heater, said method comprising:

decreasing water or steam in an interior of said hydrogen generator when a detection signal detected by said combustion sensor reaches, with a frequency of predetermined number of times or more, a numeric value at which a flame vanishes in said reformer heater, during a time period that elapses from when a temperature of said shift converter reaches a shift reaction temperature range until a temperature of said selective oxidation device reaches a selective oxidation reaction temperature range.

[23] A method of operating a fuel cell system comprising a hydrogen generator including a reformer configured to generate a reformed gas from a material and steam; a shift converter configured to cause the reformed gas supplied from said reformer to be subjected to a shift reaction; a selective oxidation device configured to decrease a concentration of carbon monoxide in the reformed gas after the shift reaction to a predetermined concentration or less; a reformer heater configured to heat said reformer; a fuel cell configured to generate electric power using a reformed gas supplied from said hydrogen generator and an oxidizing gas; and a combustion sensor configured to detect a combustion state of a combustible gas in said reformer heater, said method comprising:

decreasing water or steam in an interior of said hydrogen generator when a detection signal detected by said combustion sensor reaches, with a frequency of predetermined number of times or more, a numeric value at which a flame vanishes in said reformer heater, during a time period that elapses from when a temperature of said shift converter reaches a shift reaction temperature range until a temperature of said selective oxidation device reaches a selective oxidation reaction temperature range.